

Photoproduction of Θ^+

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[hep-ph/0505134](#) for $\gamma N \rightarrow \bar{K} \Theta$

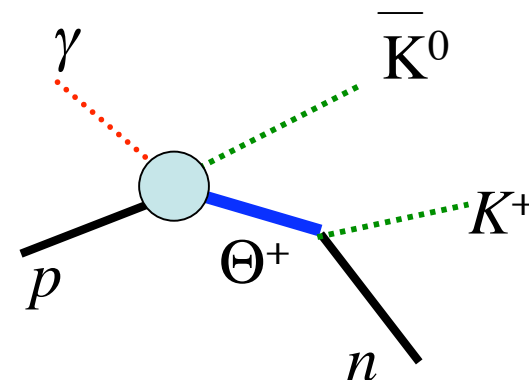
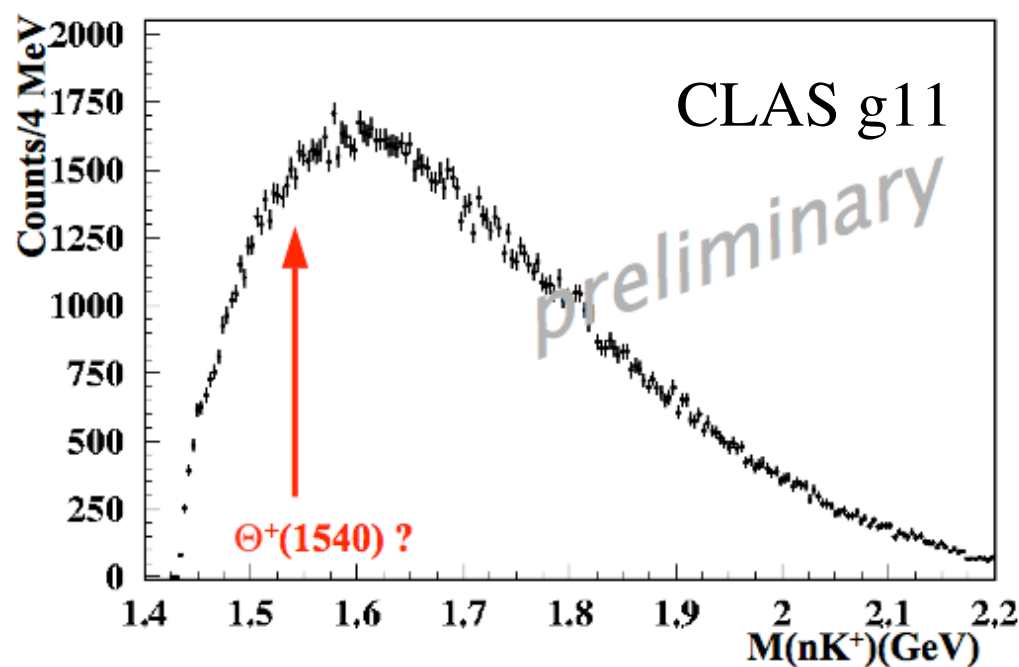
[hep-ph/0503149](#) to appear [PRD](#) for $\gamma N \rightarrow K \Lambda(1520)$

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Recent issue: LEPS observed while CLAS does not

Motivated by
K-production new J-Lab data

$$\gamma p \rightarrow n K^+ K^0$$



Taken from DeVita's
talk at spring APS meeting

**This is serious, but
Does this mean immediately the absence of Θ^+ ?**

Effective Lagrangian approach

hep-ph/0505134 Nam-*Hosaka-Kim*

- *Tree diagrams* with interactions satisfying symmetries
- Parameters: Coupling constants and *form factors*

J^P of Θ^+

$1/2^-$ KN scattering state, $(0s)^5$ in a quark model

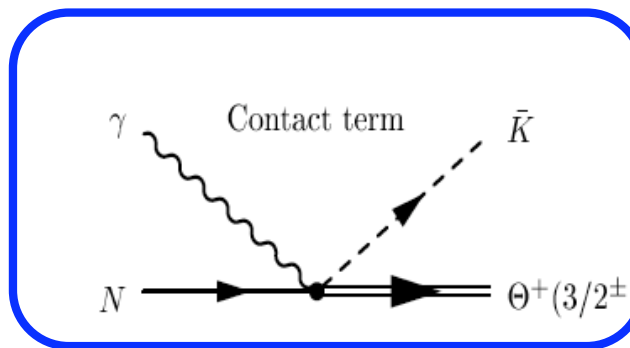
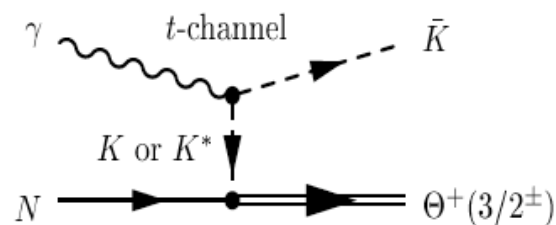
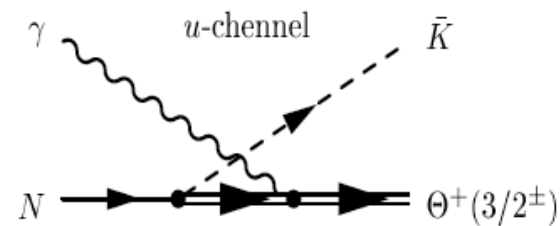
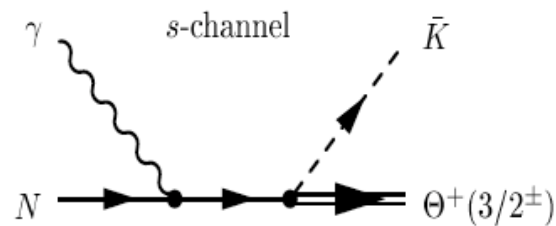
$1/2^+$
 $3/2^+$ } LS partner of $L = 1$ state

$3/2^-$ Could be a narrow resonance

We consider these

 See the poster by Hyodo, Tomorrow afternoon

Tree diagrams



present only for n-target

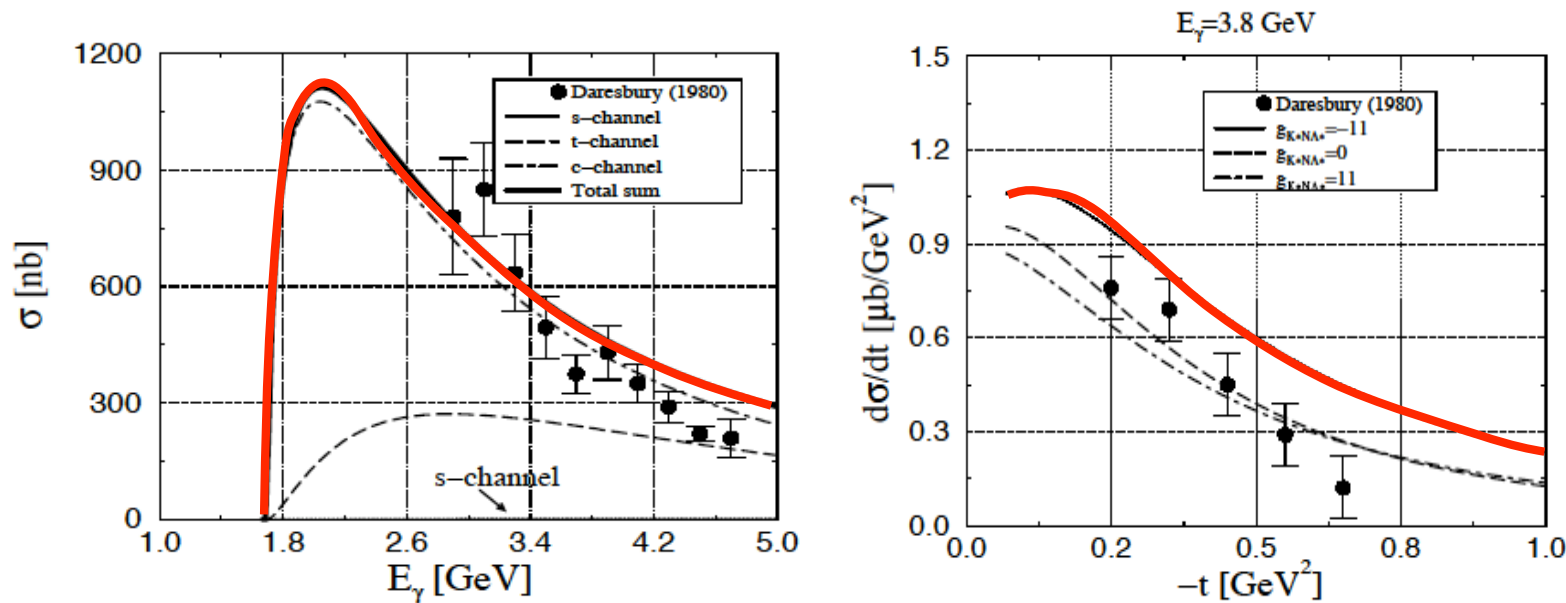
For $J = 3/2$, only **PV** scheme is possible

Before the Θ -production

$\gamma n \rightarrow K^- \Lambda(1520)$ and $\gamma p \rightarrow \bar{K}^0 \Lambda(1520)$

was studied and large **pn** asymmetry was known to us

Nam-Hosaka-Kim, hep-ph/0503149 to appear PRD



$$\Lambda(1520) J^P = 3/2^-$$

Form factor	F_1	
Reactions	<u>$\gamma p \rightarrow K^+ \Lambda^*$</u>	<u>$\gamma n \rightarrow K^0 \Lambda^*$</u>
σ	$\sim 900 \text{ nb}$	$\sim 30 \text{ nb}$
$d\sigma/d(\cos \theta)$	Forward peak	Peak at $\sim 45^\circ$
$d\sigma/dt$	Good	No data

$$\Lambda = 700 \text{ MeV} \Leftrightarrow r \sim 0.8 \text{ fm}$$

The presence (for p) or absence (for n) contact term
is important

LEPS data seems to support this result

Charge exchange

γ **p** \rightarrow K^+ $\Lambda(1520)$ **Charge exchanged**

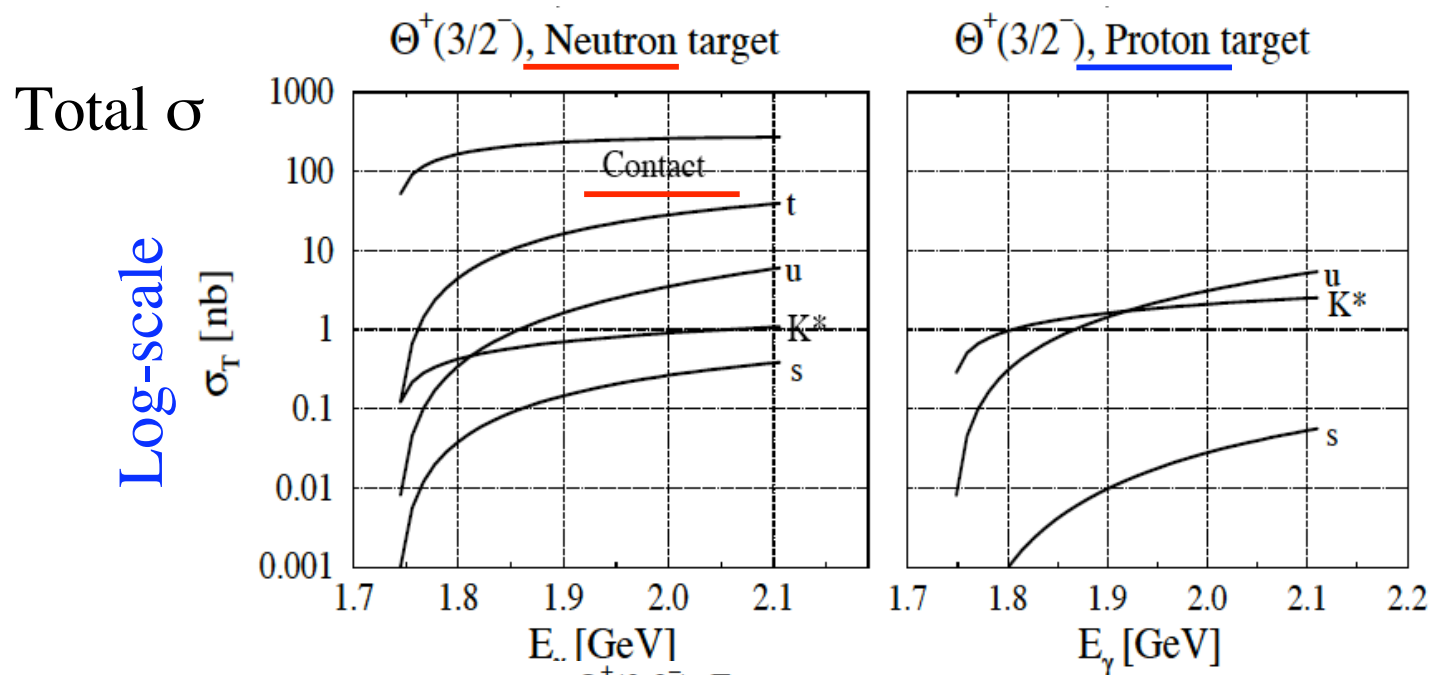
γ **n** \rightarrow K^0 $\Lambda(1520)$ **not exchanged**

γ **p** \rightarrow \bar{K}^0 Θ^+ **not exchanged**

γ **n** \rightarrow K^- Θ^+ **Charge exchanged**

 Dominant reaction

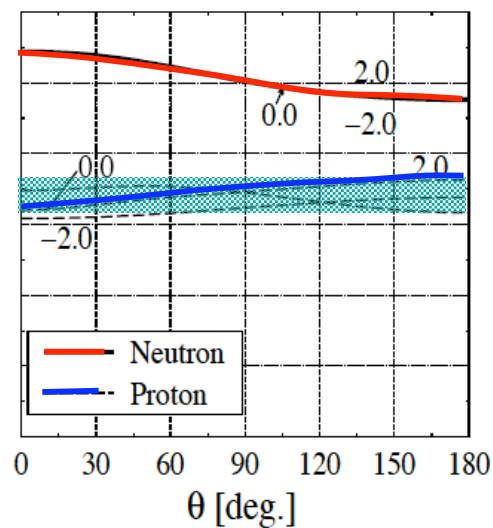
Theta production, $J^P = 3/2$



Angular dist

Log-scale

$\Theta^+(3/2^-)$, $E_\gamma = 2.0$ GeV

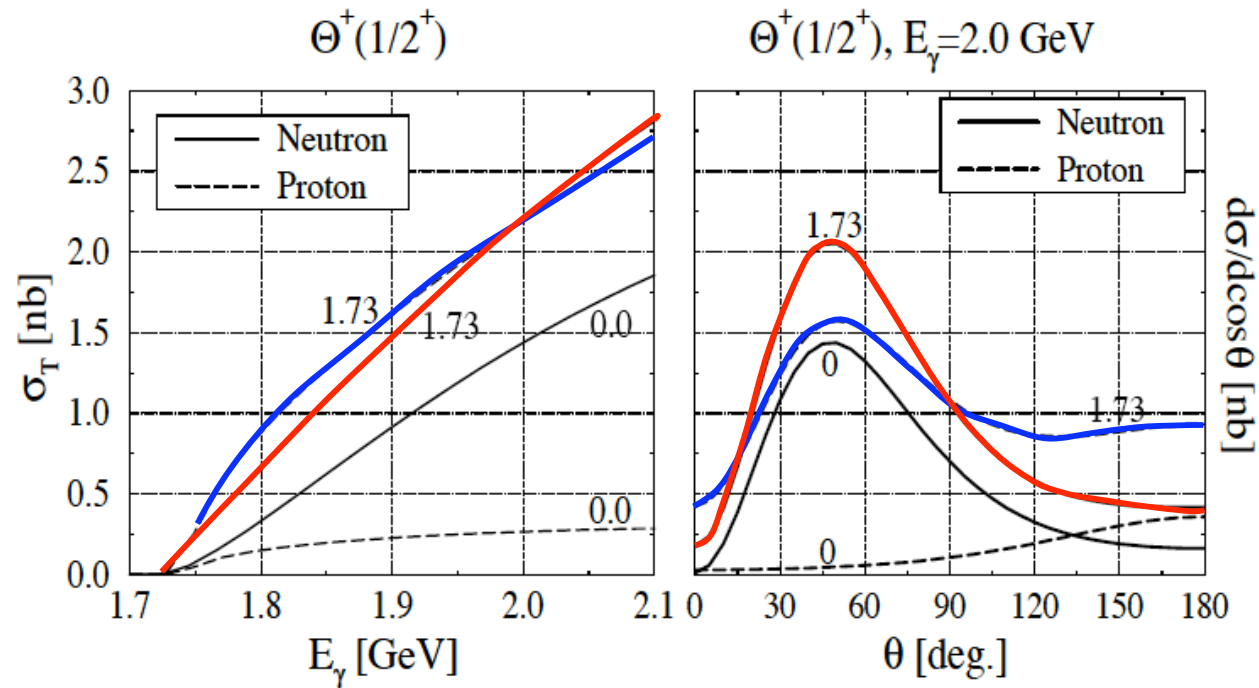


neutron ~ forward peak

Contact term

proton ~ rather flat

$$J^P = 1/2^+$$



The contact term plays more important role for $J^P = 3/2^-$ than $1/2^+$

Predictions

$$\Lambda = 700 \text{ MeV} \Leftrightarrow r \sim 0.8 \text{ fm}$$

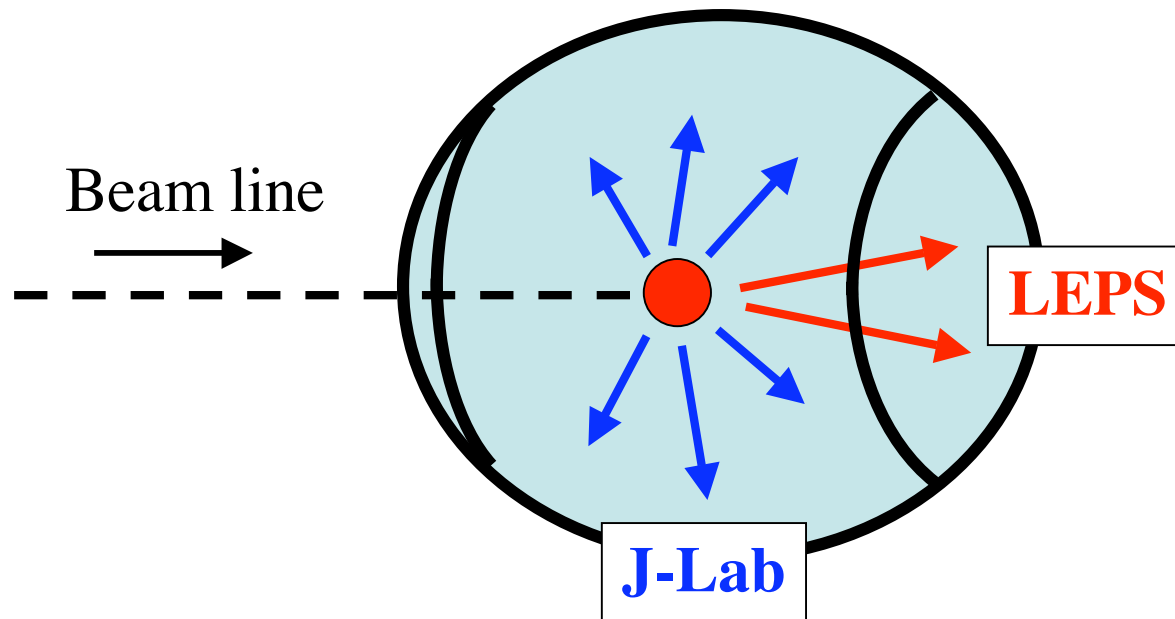
J^P	$3/2^+$		$3/2^-$		$1/2^+$	
$g_{KN\Theta}$	0.53		4.22		1.0	
$g_{K^*N\Theta}$	± 0.91		± 2		± 1.73	
Target	n	p	n	p	n	p
σ	$\sim 25 \text{ nb}$	$\sim 1 \text{ nb}$	$\sim 200 \text{ nb}$	$\sim 4 \text{ nb}$	$\sim 1 \text{ nb}$	$\sim 1 \text{ nb}$
$\frac{d\sigma}{d\cos\theta}$	Forward	$\sim 60^\circ$	Forward	–	$\sim 45^\circ$	$\sim 45^\circ$

- We see a large asymmetry between pn targets
- If Θ^+ is laeger (small Λ) cross sections may be smaller and even more forward peaking
- $\sigma \sim \text{few nb}$ or less is consistent with the CLAS result

LEPS has observed but CLAS does not

LEPS: forward angle region

CLAS: side

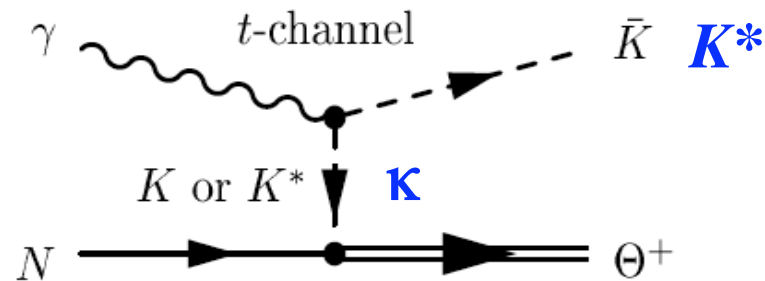


Their results are *not inconsistent*

(2) $K^* (1^-)$ production

- Physics in the t-channel

Now $\kappa (0^-)$ is allowed to be exchanged



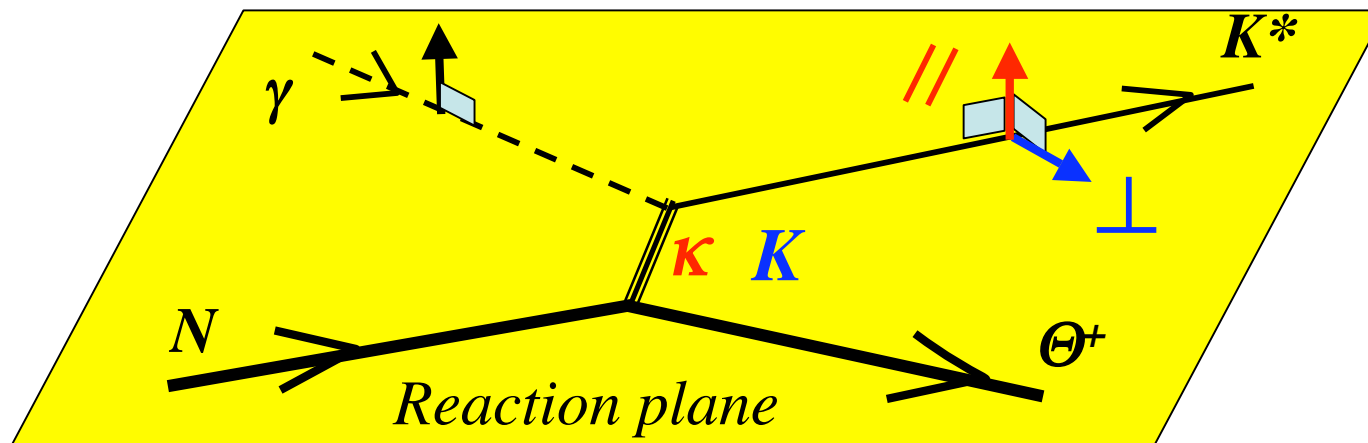
Exotic tetraquark κ may couple strongly to Θ^+

D.P. Roy, J. Phys. G30, R113 (2004)

- Using polarizations of γ and K^* , we can distinguish the exchanged particles

Polarizations as a particle filter

Pol. of γ perp. to react. plane



If parallel [$//$], only κ is exchanged

If perpendicular [\perp], only K is exchanged

Summary

Photoproduction, revised

- *We found a large *pn asymmetry*, especially for $J = 3/2$
- *No signal in the present CLAS data does not lead immediately to the absence of Θ^+
- **Kinematics* at LEPS is very interesting
- * K^* can be used as a *particle (t-channel) filter*